Strategies for building radical innovation potential: exploring the role of collaborative creative design methods

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STRATEGIES FOR BUILDING RADICAL INNOVATION POTENTIAL: EXPLORING THE ROLE OF COLLABORATIVE CREATIVE DESIGN METHODS

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ABSTRACT

In this paper, we present an empirical research on Collaborative Creative Design Methods (CCDM) that are used in response to new environmental challenges which impel firms to revised Radical Innovation (RI) strategies. This work emphasizes the need for combining social and organizational perspectives on RI strategies, with the most recent cognitive perspectives on creative thinking and design theory. Drawing on the results from the in-depth case study of a firm operating in the aeronautics industry, our study provides an empirically based account of how cognitive and social dynamics may interplay at work and suggests an integrative analytical framework for understanding the role of CCDM in building strategic RI potential.

INTRODUCTION

Over the last years, many factors have increased the need for radical innovation (RI) in several industries (e.g.: automotive, aeronautics, energy, transports). In the aeronautics industry, for example, growing environmental challenges as well as intensive R&D competition coming from emerging countries are presently impelling firms to profoundly revise their new product development (NPD). Of course, facing RI challenges is not a new phenomenon as such (Tushman and Anderson 1986) and past research already introduced notions such as “disruptive innovation” (Christensen 1997) or “major innovation” (O'Connor 2008) to characterize and cope with these specific situations (Leifer, McDermott et al. 2000). However, in practice, RI strategies are still in many cases only driven by individuals or isolated groups which often face strong organizational and managerial resistance. In such context, an important issue is how to combine network building with disruptive ideas generation in order to build successful RI strategies?

It is currently known that RI requires different organizational and managerial tools from those used for incremental innovation (Leifer, McDermott et al. 2000). Compared to classic NPD methods (Cooper 1994), managing for RI thus necessitates paradoxical processes to prevent from both organizational “isolation” and conceptual “repetition.” Organizational and social perspectives have already identified isolation threats and provided a solid managerial basis to build network and protect innovation cells (O'Connor 2008). Likewise, socio-psychological and cognitive perspectives have proposed methods to generate disruptive ideas and avoid fixation effects (Finke, Ward et al. 1992). However, past research has not paid full attention to the combination of both perspectives. While organizational works tend to overlook the ways in which to concretely maintain high originality all along the RI process, cognitive works did not identify organizational means to manage isolation threats that affect RI projects. As a result, even though RI has become a key element for strategic change in many industrial sectors, managerial processes which could support both network building and disruptive ideas are still lacking.

This paper aims to fill this research gap by exploring the role of collaborative creative design methods (CCDM). Building on previous theoretical works in this area (Elmquist and Segrestin 2009; Hatchuel, Le Masson et al. 2009), as well as findings from a case study of a firm operating in aeronautics industry, we analyze how the implementation of a CCDM enabled the studied firm to combine network building with disruptive ideas generation when facing RI challenges. Our findings provide evidence of how the selected CCDM made it possible to foster network building by revisiting both the internal and external boundaries of the firm. Likewise, our findings demonstrate how the selected CCDM fostered the generation of disruptive ideas by involving participants in divergent thinking and activating expertise in an original way. As a result, the scope of our study, which distinctively integrates the analysis of the "fuzzy front end" of the RI project, allows us to furnish an empirical based account of the cognitive and social dynamics interplaying at work and to suggest an integrative analytical framework for understanding the role of CCDM in building strategic RI potential.

The paper is set out as follows: in a first section we discuss the theoretical background of our study and argue that both social and cognitive perspectives need to be combined when dealing with RI strategies. After indicating the interest of CCDM in doing so, we present our research setting in a second section and describe the methodology followed to carry out our case study. For confidentiality reasons the firm studied was renamed "Aerofirm." In the third section, we introduce our analytical framework and provide empirical evidence to support our main findings which are then discussed in the fourth section. Conclusions and directions for further research are eventually suggested in the last section.

THEORETICAL BACKGROUND

In this section we discuss the theoretical background of our study. After detailing social and cognitive perspectives on RI strategies, we synthesize their contributions (see Table 1) and further argue that they need to be combined to avoid both "isolation" and "repetition" threats that affect RI projects. Contending that the way in which network building and disruptive ideas generation may then interplay in practice is an empirical question, we finally draw on recent theoretical research on innovative design processes. While helping us deepen our assumptions about CCDM, this also provides us with an enriched range of constructs to guide our empirical investigation.

Social perspectives on RI strategies

Social perspectives on RI strategies emphasize the relation between individuals and firms during innovation projects. This literature deals with organizational aspects, political games, profession, and inter-firm relationships. As past research demonstrated that RI is often the fact of small deviant teams and isolated individuals, these research works above all focused on various elements which may support such distinctive initiatives within firms.

From an organizational perspective, Lorsch and Lawrence (1965) emphasized the need for cross-functional teams which may efficiently catalyze the different departments of the firm. It was identified that innovation cannot be only embedded in activities sustaining exploitation processes. Accordingly, past research further clarified the need for flexible structure to manage exploration processes, for example by conceptualizing "adhocratic" or "ambidextrous organization" (Mintzberg 1979; Tushman and O'Reilly III 1996). More recently, when introducing the notion of "major innovation", O'Connor (2008) observed that such innovation requires an identifiable organization with specific links to the whole organization: identifiable organization, exploratory process, nurturing appropriate skills and talents, mechanisms for portfolio management, top management recognition (O'Connor and DeMartino 2006;

O'Connor 2008). Likewise, longitudinal studies on innovation carried out by Christensen (1997) in established firms led to introduce the notion of "disruptive innovation", which was further developed by Christensen and Raynor (2003). They particularly showed that small teams operating outside the usual business rules were often crucial actors to cope with RI issues. Finally, as organizational isolation threats also concern the firm itself, relatively to its environment, other research works have proposed to focus on inter-firm relationships to develop new type of competencies and increase innovation capabilities with new kinds of partnerships. In such perspectives, the firm should thus be able to revisit both its internal and external boundaries to manage network building all along the RI process.

In terms of tools and methods, key elements were proposed to avoid organizational isolation, such as innovation hubs and top management support. For example, Johnson (VP of Booz Allen & Hamilton) and Jones (1957), already identified that innovative projects should be managed differently from current projects and insisted on the need to take into account the degree of innovativeness in NPD. At that time, they emphasized the role of specific new product departments. More recently, Leifer *et al.* (2001) have defined RI as a product or a process with either unprecedented performance features or familiar features that offer significantly improvements in performance or cost that transform existing markets or create new ones. Their studies have therefore attempted to propose effective ways in which to manage RI in established firms. They insist on the need for "RI hubs" to protect these new types of projects from firms' inertia and to guarantee access to resources from parent companies.

In our view, organizational and social approaches define network building (e.g.: organizational flexibility, top management support, people commitment) as a key element to manage RI processes in established firms. Still, although this element appears clearly necessary to make ideas accepted by the whole organization and its environment alike, managing network building independently from disruptive ideas generation often limits conceptual exploration. While previous perspectives do not pay full attention to these issues, cognitive perspectives provide a solid rationale to avoid "repetition threats" which, in many cases, affect RI projects.

Cognitive perspectives on RI strategies

Cognitive science and psychology are those sciences that study the mechanisms and processes of human thought. As "cognition", as a whole, is a very large issue, we here restrict our literature review to general research on "creative thinking." Literature on this topic mainly deals with skills, competencies and cognitive mechanisms of individuals involved in creative tasks.

Past research provides several recommendations and techniques to enhance creative thinking and avoid conceptual repetition, such as divergent thinking, group of creative thinking and problem solving methods. In psychology, following the work of Guilford (1959) on divergent thinking, tests of "creative thinking" were developed to train creativity skills. To evaluate these skills authors proposed four main criteria: fluency, flexibility, originality and elaboration. In cognitive science Jansson and Smith (1991) observed and described a phenomenon called "design fixation." They carried out researches on cognitive mechanisms that underlie people's production of new ideas and novel solutions to creative problems (Finke, Ward et al. 1992). More recently, scholars have underlined efficient ways in which to overcome "fixation effects" by, for instance, teaching how to manage the interplay between divergent thinking and convergent thinking to designers (Hatchuel, Le Masson et al. 2010). It

should be noted that these works were mainly done in schools and universities. In industries, since the middle of the twentieth century, industrials have also evaluated the need for originality and disruptive ideas to innovate. They thus have developed their own methods to improve collaborative creativity. Osborn (1957) for example early popularized one of the most famous group creativity techniques: the "brainstorming." Having noticed that group members inhibit their ideas if they think they should not be well assessed by the group, he proposed rules to guarantee efficiency during group sharing: focus on quantity, withhold criticism, welcome unusual ideas, combine and improve ideas. Meanwhile, problem solving methods were also developed in engineering science and the most famous one remains probably TRIZ, which was invented by Altshuller (1984) for generating innovative solutions from an algorithm approach and a database of past inventions.

In our view, developing creative thinking skills and collaborative creativity abilities are key elements to generate disruptive ideas within firms. While having identified the main threats (e.g.: fixation impeding disruption and inhibition impeding idea generation) to disruptive ideas generation, past research provides key elements to overcome them. Yet, managing these elements independently from network building does not avoid organizational isolation either in the company itself or in the whole industry. As a result, it seems that, compared to classic NPD methods, managing for RI requires paradoxical processes that have to combine cognitive strategies, which allow for disruptive ideas, with network building strategies, which could commit a large array of key actors.

Combining disruptive ideas and network building for RI strategies

In this section we briefly synthesize the main contributions of previous literature (see table-1) and further argue that both social and cognitive perspectives need to be combined in order to build RI strategies.

On the one hand, as seen previously, social perspectives emphasize the need for protecting RI projects in established firms and provide key elements to support these projects until the launch on the market. Such perspectives make clear that RI projects are so different from current activity, that they require specific type of organization and management techniques. Some authors even go up to propose that the project should run outside the firm to be protected from main firm inertia. Still, although social perspectives emphasize the importance of network building for incubating breakthrough projects, these approaches do not deal with the tools and methods that make it possible to provide and maintain disruptive ideas throughout the project. This makes RI projects very vulnerable to repetition threats and "fixation effects", as defined by cognitive approaches. On the other hand, cognitive and psychological research works precisely provide techniques and tools which can be used to develop individual creative skills. Likewise, these research works have led to develop specific collective rules to guarantee disruptive ideas production during creativity group sessions. However, whereas these approaches insist on the need for divergent thinking to provide originality and break away from current practices, they do not pay full attention to the fact that disruptive ideas are running a high risk of isolation at early stages of RI projects. This is all the more problematic, as RI projects highly depends on such organizational issues, as demonstrated in previous section.

For all these reasons, we believe that RI innovation success not only relies on managing one or the other dimensions emphasized by social or cognitive perspectives, but fundamentally depends on the ability to combine both. To our knowledge, the way in which to do so has not been explicitly addressed by past literature. We thus contend that exploring the concrete

interplay of both social and cognitive dimensions should be addressed, in the first place, with rigorous empirical studies. In addition, one of the phases that seem to be critical for RI lies in the fuzzy front of innovation (Reinertsen 1994; Koen, Ajamian et al. 2001). Thus, to catch both social and cognitive mechanisms involved in such phases, our empirical study would need to address the process since ideas generation, a stage where these mechanisms seem to be particularly instable. Because addressing early stages of RI projects requires defining ex-ante constructs that should be carefully confronted to reality, we now review recent theoretical works in the field of innovative design processes which would help us deepen our assumptions.

Table 1 - Social and cognitive perspectives for RI strategies

Characteristics	**Social Perspectives**	**Cognitive Perspectives**
Theoretical Foundations	Management Science, Organization theory	Cognitive science, Psychology
Definitions and approach to radical innovation	Radical innovation is the outcome of successful deviant processes in established organizations	Radical innovation is the outcome of successful processes of creative thinking and rule breaking
Emphasized issues	Tools, methods and organization used for exploitation are not adapted for exploration and RI RI needs organic structure, top-management support, cross-functional teams Main strategic objective is to avoid organizational "isolation"	Traditional ways of reasoning (e.g.: problem-solving, optimization) are not adapted to rule breaking and RI RI needs divergent thinking to prevent from fixation effects. Main strategic objective is to avoid "repetition"
Fundamental Work	(Leifer, McDermott et al. 2000; O'Connor 2008) (Cooper 1994)	(Osborn 1957) (Jansson and Smith 1991)
Literature gap	Where do new ideas come from? How to manage conceptual breakthrough? How to generate disruptive ideas?	How to collectively develop new ideas? How to make "wild ideas" accepted by top-managers? How to federate people and manage network building?

Collaborative creative design for building RI potential

Le Masson, Weil and Hatchuel (2006) have highlighted new phenomena that affect traditional NPD and identified three important points which render innovative design capabilities necessary. The first one is the accelerated path of change within a dominant design itself. The second one is the apparition of new kinds of products on the market that did not exist few years earlier, albeit not being very well linked to a clear dominant design. The

third one is the product identity renewal: the product identity becomes uncertain, destabilizes both users and designers and the identity of the object is no longer an input of the design process (Le Masson, Weil et al. 2010 (to be published)). From a broader perspective, the authors argue that this instability of object identity may lead to major uncertainties in industries. Therefore, to survive in what the authors call an "intensive innovation competition", where neither the required skills to design the new product, nor the knowledge to define new performance criteria are known, firms need to integrate strategic design capabilities.

Taking such a view on RI strategies, (Hatchuel, Le Masson et al. 2006) have recently proposed a new strategic model for managing firm design capabilities. Insisting on the fact that their "model" does not aim at fixing the universal attributes of "good" design, they have formalized logical operators which make it possible to further understand the co-expansion of both knowledge and concepts during innovative design processes (Hatchuel and Weil 2002). To build RI potential, firms therefore need to integrate new kinds of organizational means and manage growth in links with "design strategies." While having recently had a strong impact in the field of engineering design as well as of design theory (Hatchuel and Le Masson 2007; Le Masson, Hatchuel et al. 2007; Kazakçi, Hatchuel et al. 2008; Shai, Reich et al. 2009), these theoretical research works have also taken the first steps in conceptualizing new collective design processes. Aiming at providing theoretical insights to integrate innovative design capabilities within the firm, these works have characterized critical stages to organize collective design, such as: "staging the initiative", "sharing knowledge", "conceptual exploration" and "making propositions." However, while providing us with useful constructs to guide our empirical observation, these research works have mainly remained theoretical and, despite one published case study (Elmquist and Segrestin 2009), empirical research is still required to analyze the role of what we here suggest to broadly define "Collaborative Creative Design Method" (CCDM) in building RI potential. Particularly, our literature review shows that there is a need for further understanding how both disruptive ideas generation and network building may be concretely combined during such processes.

METHOD

Research Setting

Our research is based on a one-year collaborative research study in Aerofirm, a firm operating in the aeronautics industry. Aerofirm was founded in 1930 as a supplier of energy systems for airframes; in the middle of the 1980's, it became the world leader of its core business.

Recently, RI became a growing issue in Aeronautics: the A380 program, the more electric aicraft, and composite materials structures… And due to new environmental standards Aerofirm must radically cut its product's ecological footprint in less than twenty years. Based on this observation, Aerofirm decided to launch a large participative process around a breakthrough concept, which was "*New green energy systems for aeronautics*". This project was viewed as an RI and selected a CCDM, to support it (Elmquist and Segrestin 2009; Hatchuel, Le Masson et al. 2009). Aerofirm also agreed on a research study that would use this experience as a source of data towards a more systematic exploration of operational rules for IRI. To facilitate the study, the authors received full access to the entire process. The first author was fully integrated to the collaborative creative process for three years (his first year ended the date of this issue), as a PhD student and was involved in the daily task activities of the firm.

Data Collection and analysis

Our study was mainly based on a one year longitudinal study and also integrated different sources of data such as qualitative methodologies: semi-structured interviews and archival analysis (Yin 2003). As we were fully integrated to the process we build an exhaustive database of documents that were produced internally and externally. We also collected many data from informal and formal discussions with the participants.

Semi-structured interviews

At the beginning of the research program, we interviewed 20 managers of innovative projects to collect feedback and to analyze current and past methods used for innovative design in the company. We conducted a total of 25 semi-structured interviews in the firm. We initially interviewed project managers that had worked on innovative project between the sixties and the nineties. We led 6 interviews with 5 retired persons. They gave us an historical vision of the way product were developed before the implementation of "systematic design" principles (Pahl and Beitz 2006). After this first interviewing phase, we interviewed various engineers involved in the ongoing innovative development as well as most of the participants to the collaborative creative process. This approach made it possible to both analyze current practices and collect feedback on the role of the CCDM in building RI strategies.

Corporate history and archives materials

In parallel with the interviewing phase, corporate archival analysis made it possible to track the evolution of Aerofirm strategy, product development process, competencies, and social change. A book written by a senior manager on the firm history was of critical importance to our understanding of the evolution of the core competencies at Aerofirm. In addtion, we analyzed internal reports and meeting minutes, to evaluate social interactions during processes. Finally, by getting access to the company's archives we succeeded in analyzing its evolution throughout time.

Video analysis

All the sessions of CCDM were either audio or video recorded. Using the logical operators provided by Hatchuel and Weil (2002) to code the 8 hours of film, we succeeded in identifying how both cognitive and social mechanisms dimensions were interplaying at work. In itself, this recording provides an exhaustive database that could contribute to further research on CCDM.

Access to top management meetings

Accessing to steering committee facilitated the analysis of the impact of strategic management decisions on the RI process. It also made it possible to communicate, discuss and challenge our interpretations with senior and top managers.

High involvement in the process

Finally, our study distinctively involved one of the authors all along the collaborative process. He participated to all the workshops and the weekly project team meetings. Likewise he took part to high confidential work led by a restricted managing team during the CCDM. This high involvement also allowed him to take many notes during formal and informal discussions inside the firm throughout the study. This approach, combined with the longitudinal view described above, made it possible both to have an exhaustive database of the process and to collect informal data which might not have been collected with traditional interviews. We thus had access to data beyond the produced "official" documents and

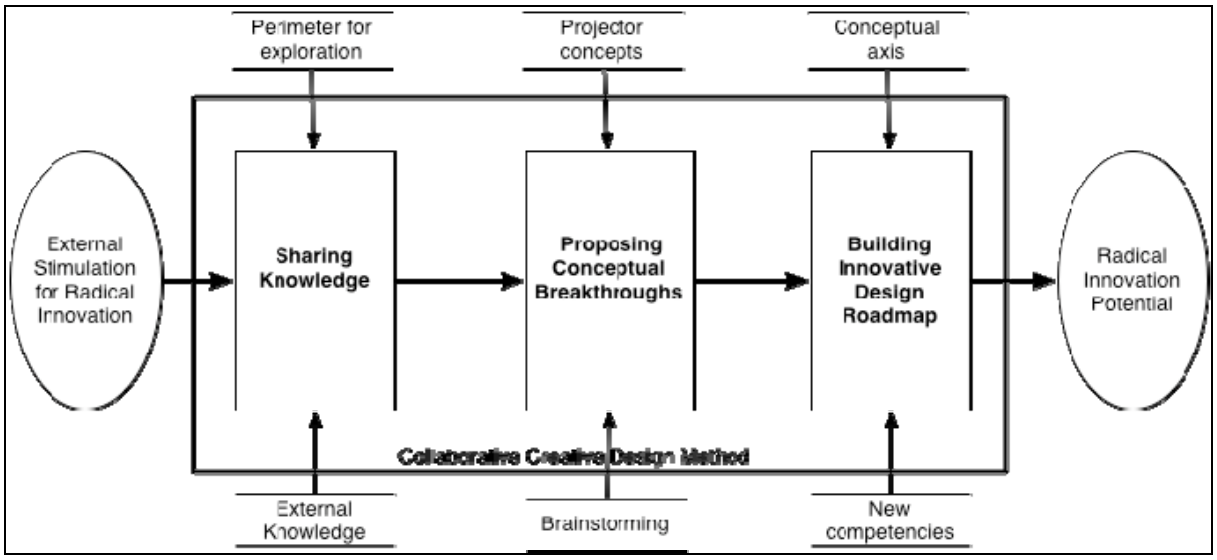
discourses, which seems critical when dealing with RI strategies.

FINDINGS

Analytical Framework

In this section we describe our framework (see figure 1) based on the CCDM and we define each element of this framework. Table 2 presents the evidences collected from our different sources of data during the collaborative creative design method.

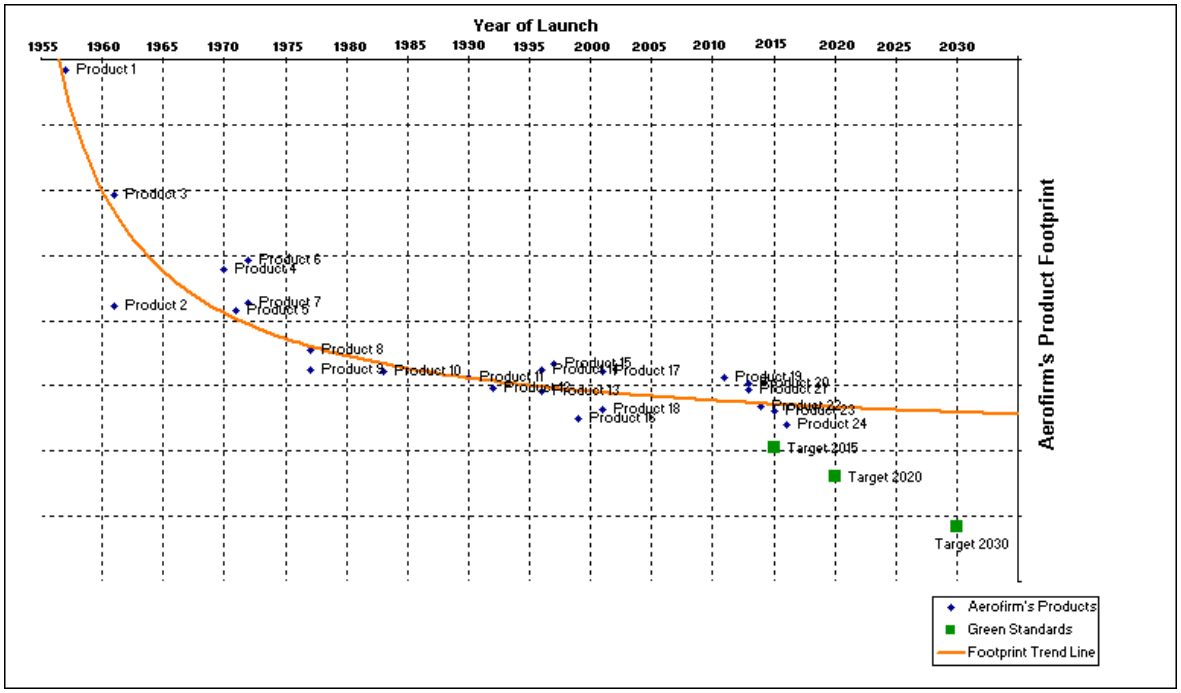
Figure 1 – Emerging framework for CCDM analysis



External Stimulation for Radical Innovation

In a context of environmental and energetic crisis, a deep change has recently appeared in aeronautics industry. Until 2008, incremental innovation processes were adequate to improve Aerofirm current products on well-identified customer needs (e.g.: reduction of product mass, direct operating costs). But recently (2008-2009), variations in oil prices and new project of environmental regulation revealed the limit of incremental innovation to prepare the firm for the future challenges.

Figure 2 - Environmental footprint of Aerofirm's products



On figure 2 are presented in blue Aerofirm product's footprint by year of launch. The trend line (orange) shows a considerable drop of the footprint during the first twenty years (1955-1975) and a significant stabilization the next forty years (until today). The new aeronautics standard was included in green. This graph makes it possible to see the limit of Aerofirm current design capabilities to reach the new standards' objectives. Based on these observations, the CEO asked to its CTO in 2008: "I would like you to do the Prius project of Aeronautics". This sentence was the first expression of a need for a Radical Innovation initiative at Aerofirm. Indeed, the new environmental standards let the R&D division without solution. In fact, the sponsor of the collaborative creative design method, talking about the objective of 2030, said at the kick off meeting: "It is clear that we do not know how to achieve these objectives."

The CTO and the sponsor visited an aeronautics firm that had a recent success in Radical Innovation using the same method. The CCDM was launched only two weeks after this visit.

It should be noted that while the objectives of this initiative was long term (20 years vision), the time elapsed between the first request of the CEO and the launch of the CCDM was barely a year: there was a short term imperative for long term objectives.

Sharing knowledge

Before launching the CCDM, the pilot committee proposed three perimeters for exploration to Aerofirm's top management. To have the most fruitful exploration possible, top management selected the wider perimeter among the three proposed. The CTO also insisted to integrate as much external knowledge as possible during the knowledge-sharing phase. The perimeter defined, the CCDM pilot committee sought for knowledge presentations that would permit to disrupt the dominant design. They had to be presented to a cross-functional group of 30 experts of Aerofirm: the CCDM extended group. This group would follow the CCDM until the creativity workshop included.

We noted that presentations from industrials had a high impact on participants and were well appropriated. We think that appropriation is easier when a new technology or business model

is presented with its application and even more when the application is close to an aeronautics application. Surprisingly, we also noted that internal knowledge presentations were of high importance because many of innovative projects were not known by the CCDM extended group. Furthermore, the presentations made it possible to review old product concepts, which were interesting to integrate into the creative workshop. It was also during this stage that the pilot committee started to review the design capabilities and the ecosystem of Aerofirm to permit better efficiency during the next phase.

Proposing conceptual breakthroughs

Once the pilot committee had prepared the projector concepts to guide the creativity workshop and exploit the whole initial perimeter, the executive committee of Aerofirm validated them. We later noted that this validation was of high importance to have an uninhibited creativity session. Indeed, during the CCDM, the project manager had to remember that the top management had validated the projector concepts. After the workshop we find that many disruptive ideas proposed, were already existing in the firm but had not been shared: they were either in isolated innovative projects or in the minds of some individuals. We also noted that during the preparation of the workshop, the pilot committee had already visited many disruptive ideas resulting from the workshop. Indeed, many participants were frustrated after the two days of workshop, they expected for more creativity during the workshop. One of the participants said: “To be honest, I feel slightly disappointed, I thought we would go deeper into the concepts.”
Indeed, we assume that the workshop was of key importance for federation of disruptive ideas in Aerofirm more than for new idea generation. It was, in fact, difficult for the participants to cover both the whole conceptual potential of the perimeter and to produce new knowledge on new concepts.

Building a roadmap for innovative design

Before entering this phase, the pilot committee categorized the disruptive ideas that were proposed during the creativity workshop into eight different conceptual axes. These axes would permit to guide the new competencies acquisition during this phase and avoid repetition. In fact, the risk here is to kill disruptive ideas by sticking to the firm competencies. As it was said, the knowledge-sharing phase permitted to review the ecosystem of Aerofirm. Indeed, the business model and the value chain were challenged with the innovative project examples that were presented. It permitted for example to give novel values to the breakthrough ideas that had no interest in the current ecosystem. The new vision of the ecosystem also made it possible to propose different way of designing: future products should not anymore be designed for the Airframers first, but for specific usages of the final customer.

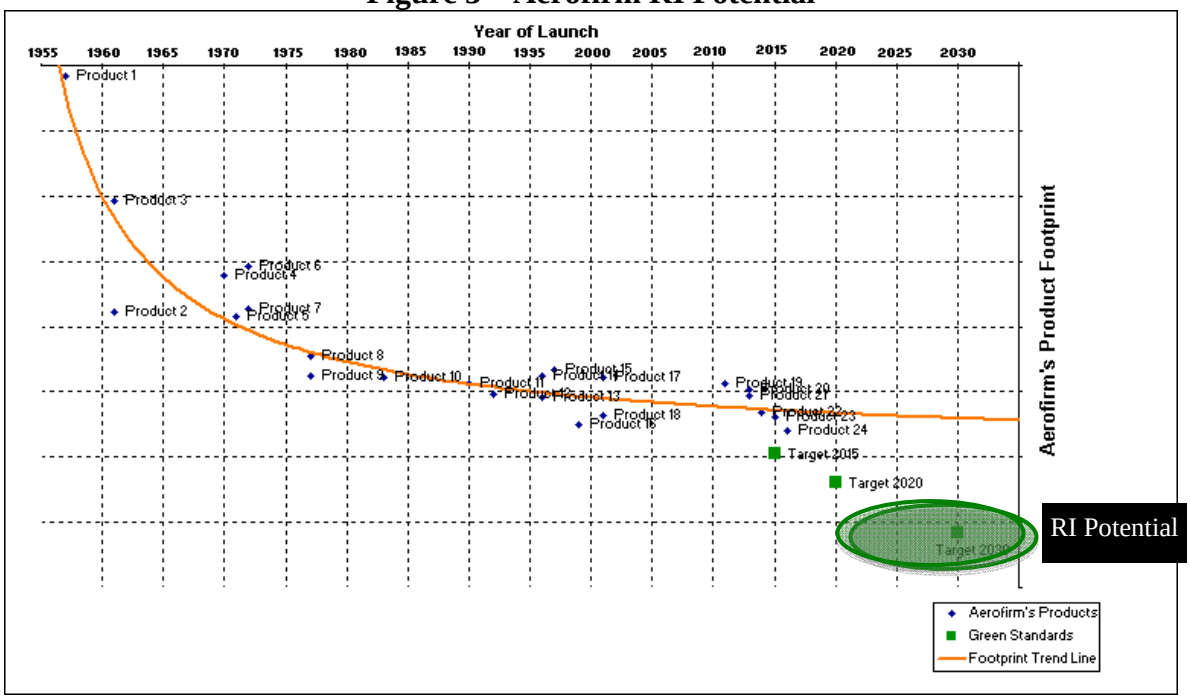
As the conceptual axes were intentionally chosen disruptive for the company competencies, engineers had to seek for new knowledge internally (Aerofirm) and externally (Firm of Aerofirm’s holding and other). For this phase, a working group was established. This team had no tasks specifications but was rigorously managed with objectives for the weekly meetings. Internally, we noted that, the aeronautics literature was read differently by the working group and also by employees not involved in the working group that had heard about this initiative. Indeed, in this phase the working group started to share knowledge by emails but also received emails from people not involved in the process. The conceptual axis, in fact, worked as attractors for new “exotic” knowledge. Externally, the CCDM working group presented the conceptual axis to different firms of Aerofirm’s holding to seek for new knowledge. A total of three partnerships/synergies were launched with these firms to produce knowledge and develop the conceptual axis. A partnership was also signed with a small firm

that had already been identified by the firm before the initiative but that had not found any place in Aerofirm R&D roadmap. And a study was launched with a laboratory on a new architecture concept. It should be noted that the first partnerships were signed only six months after the launch of the CCDM, which is extremely rapid compared to the long-term objective of the initiative. We assume that the conceptual axis made it possible to give a clear strategy to the innovative design in Aerofirm and thus build a strong network for Radical Innovation.

Building a potential for radical innovation

In our view this method gave the firm a radical innovation potential – see figure 3. This figure includes the RI potential zone resulting (green zone) from the studies of the last phase. It clearly shows that the environmental standard objectives could be reached due to the work done on disruptive ideas.

Figure 3 – Aerofirm RI Potential



We talk about potential because at this stage, only little resources were engaged in the initiative. But instead, it led to a clear innovation strategy including disruptive ideas giving new ways to achieve the new standards objectives and new partnerships / synergies and competencies acquisition plan giving means to reach these targets. The CCDM thus, makes it possible to have disruptive ideas sharing a new vision of the ecosystem and build a strong network that can be activated rapidly according to Aerofirm's ecosystem variations and stimulations.

Otherwise, the CTO recently gave a presentation of the innovative design Roadmap of Aerofirm to the top management of its holding, proving the interest for the CCDM at corporate level.

Table 2 - Sources of empirical evidences at each stage

Stages	**Top-management: Assisting to steering committee Involvement in the value management: Managing the process with both the Project manager and the consultant**	**Involvement in daily task: Phd involvement in the company working group as engineer Participation to the entire method (every workshops)**	**Qualitative methodologies: Video Analysis, Semi-structured interviews, Archives analysis**
External Stimulation for Radical Innovation	• Aerofirm CEO says that he want to do a project similar to the Prius project of Toyota	• The sponsor says that Aerofirm have no idea of how to reach the environmental objectives. • The sponsor, the CTO and the project manager visit another aeronautical firm that just had an innovation success with the method.	• No evidence
Sharing Knowledge	• Three perimeters for the initiative are proposed to the CTO. • The executive committee select the wider perimeter among the three proposed by the CTO. • The CCDM pilot committee defines the presentations that will permit to potentially disrupt the dominant design in the perimeter chosen by the top management. • The executive committee validate the exploring concept that were prepared for the creative workshop • The CTO ask to have a maximum of external knowledge presented during the K-workshop	• The consultants help to ignore completely the current value chain • Presentation from other type of industry have a high impact on participants and are well appropriated • High rate of participation to every workshop • External and internal knowledge presentations help to review old concepts that did not enter into service until then	• Aerofirm had visited many concepts of product architectures in its history • Many exotic competencies were developed on innovative project in the past but were isolated in the firm
Proposing Disruptive Ideas	• The pilot committee prepare axis of exploration to guide and exploit the whole perimeter of the initial concept.	• High rate of participation to every workshops • Conceptual breakthrough ideas are rigorously evaluated	• Many disruptive ideas already existed in the company but had not been shared • Participants are frustrated after the two days of workshop: they expected more creativity during the workshop • Many concepts resulting from the workshop were already visited during the preparation of the pilot committee

Stages	**Top-management: Assisting to steering committee Involvement in the value management: Managing the process with both the Project manager and the consultant**	**Involvement in daily task: Phd involvement in the company working group as engineer Participation to the entire method (every workshops)**	**Qualitative methodologies: Video Analysis, Semi-structured interviews, Archives analysis**
Building innovative design Roadmap	• Conceptual axis (permitting to acquire new competencies) are build and shared with the top management. • A new kind of partnership is signed with an inventor that recently filed a patent on a new technology. This technology in partnership with aerofirm is to be developed in the aeronautics industry. • A partnership is signed with a laboratory which was not specialized in aeronautics. • Presentations of the initiative to different firm of Aerofirm holdings create synergies. • The CTO present the new concepts to the top management of Aerofirm holding • The project manager and the phd evaluate here the competencies to be acquired and the potential synergies that could emerge from the initiative using CK theory. • The future ecosystem of the firm is completely changed.	• The industrial and scientific literature is read differently by people of the working group but also by employees not involved in the working group but having heard about some of the disruptive concepts. • The working group starts to share by email the knowledge they find in the press and in the literature. • The working group receives emails and articles from employees not involved in the process. • Some employees visit the working group very often to question on the project advancement • A presentation of the initiative is made each time someone has to ask for new competencies or knowledge from another division of the firm • New seminars on technologies are implemented to share knowledge with the group of 30. • The working group improves the breakthrough ideas with concepts identified in a presentation of automotive industry researchers. • The value chain is not taken into account anymore to design the product of the future • A new way for designing future products is to be implemented	• Iterations between clients and Aerofirm during design of new products were higher in the past.

DISCUSSION AND CONCLUSIONS

This research sought to assess the impact of balancing network building and disruptive ideas for Radical Innovation. In this section we give an interpretation of our findings by presenting the role of CCDM to balance both aspects. It should be noted that while in practice this two notions are necessarily coupled, they will be analyzed separately here for the sake of clarity.

The role of CCDM in fostering network building

Revisiting the firm organization

In literature (Tushman, Anderson et al. 1997; Leifer, McDermott et al. 2000), it is commonly admitted that radical innovation processes require different types of organization than the one adapted to current product development. In our case study, the CCDM permitted to revisit the firm organization and to give to the firm capabilities to deal with radical innovation. In fact, in the phase of roadmap building, the small working group that was established to develop the conceptual axis, was a cross functional team composed of experts (Cooper 1994) that had been taught the principles of innovative design theory (Hatchuel, Le Masson et al. 2008). This team was also a pilot organization of what could later become an innovative design organization for Aerofirm. It was fully integrated to the firm but was working with different processes than the one used for rule-based design O'Connor (2008). And this organization mainly contributed to integrate the incubation capabilities suggested by O'Connor and Demartino (2006). Our study also shows that the existence of this organization was a focal point for all innovative information and knowledge that had no link with the organization current processes. We think that by implementing the CCDM Aerofirm succeeded in revisiting its organization to incubate RI capabilities for this initiative.

Revisiting the industry ecosystem

Before the CCDM, Aerofirm industry ecosystem was stable and its boundaries were well delimited. We noted that the implementation of such a method give the firm a new vision of its ecosystem. It is as if the right lenses were given to the firm to see how its environment would evolve twenty years later. Otherwise, it should be noted that after the phase of conceptual breakthroughs proposition, the firm found itself without any mean to deal with the more disruptive ideas. The work-break-down structure, usually easy to manipulate for current activities become useless. But the new vision of its ecosystem makes it possible to establish links with industrials and laboratories with which, the firm had hitherto never consider working. This new external network finally modifies the boundaries of the firm. Their outlines are not uniform anymore which could be seen as a form of instability. However, it is in these new boundaries that the firm will react more rapidly to the future solicitations from its ecosystem. This new vision of its ecosystem, actually have another effect on the firm. Disruptive ideas, for which a potential could be seen but that were uncared-for in the firm become valuable in this new ecosystem: new customers, new technologies, new business models. Indeed, due to more flexible frontiers, the firm can rethink its value chain and some ideas easily find their place.

The role of CCDM in generating disruptive ideas

Scholars (Osborn 1957; Lasswell 1960), insisted on the role of initial brief for a good efficiency in collective creativity methods. In CCDM, an initial phase is proposed to stage the initiative. We assume that this staging phase was of key importance for the process. Indeed, the steering committee and the top management were ask to chose a long-term vision and a large perimeter to force expansion.

Divergent thinking as a basic of disruption

In fact, this brief makes it possible to stage the right environment for divergent thinking. We assume that techniques for divergent thinking are more likely to provide expansion and avoid repetition than the problem solving methods. Indeed, the methods of problem solving inspired by TRIZ (Altshuller 1984), are limited to the database of invention used for the algorithm, so knowledge expansion is limited on behalf of efficiency during rule based design (Pahl and Beitz 2006). In fact, some methods such as ASIT firmly impose the close world condition to guarantee a minimal effort for the user: the solution of the problem is inside its environment. The fact that CCDM was based on divergent thinking permits to foster expansion during the process. Most authors insisted on the needs for divergent thinking in the first phase of innovation process (Osborn 1957) to provide originality. In our case study if the initiative had been limited to the knowledge of the firm none of the conceptual axis would have been proposed and the RI potential would have been extremely low.

CCDM as a mandate for disruption

Osborn (1957), noted that to avoid inhibition during brainstorming, a creative working group should be provided with several rules and the right environment because of such problems as evaluation apprehension, production blocking…We think that CCDM makes it possible to build a management system that is mandated to organize disruption. Indeed, it permits to collectively admit the benefice for the whole firm of the delegation of the function of disruption to a small group. This mandate permits to collectively break design rules and enable the proposition of disruptive ideas. Indeed the withdrawal of design rules permits to avoid quick evaluation of breakthrough. But, since design rules are removed, the firm requires new mean to activate new knowledge to develop the disruptive ideas.

Activating expertise for sustaining disruptive ideas

Expertise is of key importance in the fuzzy front end of innovation. Felk *et al.* (2009) provide us with new means to acquire new knowledge for RI. They propose to build hooks that will permit to attract new knowledge and guide knowledge production. CCDM seems to fulfill this function by guiding the roadmap proposition with conceptual axis. By providing this axis the method succeeded in developing rapidly new expertise by the actor of the working group and to activate new knowledge competencies around external partnerships. In our case study it permitted for example to create a new partnership with a firm that had been detected before the CCDM but that had no alignment with any technological strategy of the firm until then.

How to tell the future? Emerging issues for organizational research

An original change in the narrative regime

Former research on organizational identity, culture and symbolism has already studied how stories and narratives (Gephart 1991; Strati 1992; Boyce 1995; Boyce 1996; Czarniawska 1997) are crucial elements when responding to identity threats (Ravasi and Schultz 2006). To a certain extent, we believe that RI challenges constitute an extreme case of organizational identity threats. Compared to long-time industrial stories, it can indeed render established expertise as well as historical legitimacy obsolete in a relative very short time. During our empirical investigation we were able to finely grasp such feelings an emotions within the participants. At the beginning of the process, we realized how the new RI challenges faced by Aerofirm favored either traditional “nothing changes” optimistic scenarios or “we are condemned” pessimistic predictions. Interestingly, the CCDM had then a huge impact on such classic narrative regime and opened new ways in which to “tell the future.” For example, like in the case of novelists escaping the well-known writer’s blocks, some of the participants to

the CCDM started to take a "design attitude" (Boland Jr and Collopy 2004) and integrated design words to their discourses. While being aware that a finest analysis is still needed to make strong statements, for example by integrating content analysis or image analysis (Strati 2000; Kivinen 2006), we believe that our findings provide stimulating directions for further research in these areas.

"Declaring the unknown": the role of executives' legitimacy

Our results have highlighted the importance of top management throughout the CCDM. For example, we have illustrated how top managers made it possible to manipulate disruptive ideas, albeit with a high level of uncertainties. Beyond these elements, which we already consider as key findings, we believe that our study also shed light on an interesting phenomenon related to the issue of executives' legitimacy in the unknown. As we were involved in the CCDM project since the very beginning of the project, we were able to detect the role of the first "brief" given by Aerofirm's CEO. As seen previously, the "Prius brief" had a huge impact on the CCDM, participants and allow them to collectively explore beyond traditional research program. While encouraging further research on this topic, we believe that this phenomenon cannot be only assimilated to simple project team "motivation", as found at some point in NPD projects. Indeed, we argue that traditional NPD projects are situations in which people can identify "roads" in a given environment, albeit with potential difficulties, to achieve objectives affected by uncertainties. To the contrary, our findings tend to illustrate how RI situations are contexts in which the main point is precisely to build the potential for the existence of such "roads" and "environment." In such situations, the "environment" is thus itself considered as partly "unknown" and not only as "turbulent" or "uncertain"(Hatchuel and Le Masson 2007). As result, by setting an initial "brief", executives may not only provide "objectives under uncertainties", but actually perform a legitimate "unknown space" within their firms. In that sense, by acting as such, executives can "declare the unknown", which seems, in light of our empirical investigation, an important, if not necessary, condition for collective design when facing RI challenges.

Methodological limitations

Our findings rely on a one case study only. Thus, the study does not integrate rigorously contingencies variables. Yet, based on our literature review, two types of variables could be assessed for Radical Innovation projects: the minimal effort that should be engaged to avoid isolation and the minimal effort to avoid repetition. We think that variables such as the organization, the type of innovation and the performance could be interesting to study to improve the link of our study with contingencies (Tidd 2001). Otherwise, we cannot exclude the fact that other methods should be successful in building Radical Innovation Potential. And other research in established firms will help to evaluate their real value for RI. Finally, our study assesses the impact of the implementation of a CCDM that was used one time only. We thus should also propose organizational work to combine network building and breakthrough ideas in a perennial way.

Conclusions and direction for further research

Our research emphasized Radical Innovation initiatives launched in established firms in response to external challenges and which aim at building RI potential. Although past research has tended to separate organizational and cognitive strategies for RI, our study highlights the necessity of combining both perspectives. Drawing on the in-depth case study of a firm operating in the aeronautics industry and faced with new environmental challenges, our study assessed the role of CCDM to foster both aspects in RI processes. First, our findings illustrated the role of CCDM to give the firm capabilities to revisit its ecosystem and

organizational environment, which made it possible to reshape firm boundaries favorable to network building. Secondly, we highlighted the importance of CCDM for staging an environment adapted to disruptive ideas generation in the firm, which relied on divergent thinking, mandate for disruption and new expertise acquisition capabilities. Shedding light on new issues related to changes in the way of "telling the future", our study eventually suggested directions for further research.

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